Calculating Population Productivity Gaps: Current Status vs. Viability Curves for Interior Columbia Spring Chinook and Steelhead Populations

Interior Columbia Basin Technical Recovery Team
Interim Report

June 19, 2006

Introduction

The ICTRT has developed abundance and productivity criteria for Interior Columbia Basin chinook and steelhead populations using a set of viability curves specific to each Interior Columbia basin listed chinook and steelhead ESU. The approach was based on the concept of a viability curve as described in the May 2003 draft Lower Columbia/Willamette Viability Criteria report (McElhany et al. 2003). The ICTRT uses these viability curves as the basis for quantitative population-level abundance and productivity criteria. Risk levels are expressed in terms of the probability that a population will go extinct over a 100 year time frame (ICTRT, 2005). Draft ICTRT viability criteria for abundance and productivity define a range of risk ratings in terms of the projected probability of extinction over a 100 year period: High (>25% probability of extinction), Moderate (5 to 25% probability), Low risk (< 5%) and Very Low risk (<1%).

Theoretically, any combination of abundance and productivity that exceeds a target viability curve would meet the general objective. The curves were developed as a performance test—that is, if a population exhibited a combination of productivity and abundance over a particular curve (or within a zone defined by two curves), it would be assigned a viability level. The ICTRT has developed an approach for evaluating the current status of a population against its corresponding viability curve. Under the ICTRT approach, a population is assigned a current risk level relative to the corresponding viability curves using an estimate of intrinsic productivity (data from the most recent 20 years) and an estimate of recent (10 year geometric mean) natural spawner abundance. The ICTRT is developing these current status assessments for each population within the Interior basin ESUs. The assessments include specific analyses of current levels of abundance, capacity and intrinsic productivity for those populations with sufficient available data (most stream-type Chinook populations and a subset of steelhead populations).

The current status assessments provide a graphical and narrative comparison of current status relative to the viability curves. Recovery planners would like a method for quantitatively gauging the relative amount of change in survival or capacity required to move a population from current status to a particular viability level. The analysis described below provides a quantitative estimate of the gap (if present) between the current abundance and productivity estimates and alternative viability/risk levels for individual populations.

The ICTRT is developing a more detailed analysis for use in evaluating recovery strategies (ICTRT & Zabel, 2006, accompanying manuscript). That application is based on a stochastic, density-dependent matrix model incorporating juvenile, migratory and adult life history stages. The modeling approach is designed to incorporate information on the relative survival impact of assuming alternative climate regimes on the gap between current status and viability. In addition, that analysis will evaluate, for a representative subset of populations, the potential for improvements to fill the gap. We have used results from initial applications of that simple matrix analysis to generate alternative ocean survival scenarios and to estimate the effects of recent improvements to hydropower impacts on migrant survivals.

Methods

We used results from the abundance and productivity analyses derived for the ICTRT **Current Status Assessments** (ICTRT website) as a starting point in defining Observed gaps at the population level. Observed gaps represent the minimum survival change needed to elevate a particular population from its current status to a point on its target viability curve. We developed estimates for observed productivity gaps using the following analytical steps.

1) Estimate current intrinsic productivity and natural spawner abundance (most recent 20 years of stock-recruit data)
2) Estimate current spawning level associated with achieving juvenile capacity.
3) Assign each population to a category based on its position relative to the viability curve
4) Calculate gap based on the minimum distance from the abundance/productivity point representing current status and the appropriate viability curve.

<u>Step 1: Current Population Abundance and Productivity</u>

Current Abundance: We initiated our observed gap analyses using the recent 10-year geomean natural abundance levels as reported for specific populations in the Current Status Assessments.

Current Productivity: We used a simple hockey stick function as a basic population stock recruit model in our observed gap calculations[1] (Figure 1). For an estimate of current intrinsic productivity, we used the population-specific estimates generated for the

[1] We intend to expand the gap analyses to include examples based on a Beverton-Holt stock recruit function in the near future.

Current Status Assessments. The estimated productivity for each population was calculated as the geomean adult natural return per spawner over low to moderate parent spawner years from the most recent 20 year data series (usually 1979-1999 brood years). We limited the analysis to low to moderate parent spawning levels to reduce the influence of density dependence. We calculated the geomean productivity limiting the data pairs to those parent escapements that were below 75% of the assigned abundance threshold for the population. In some cases a substantial proportion of the parent spawning levels in the recent series exceeded 75% of the threshold (e.g., some Mid-Columbia steelhead populations). We calculated an alternative estimate of current population productivity, limiting the dataset to return per spawner pairs where the parent escapement was less than the median escapement for the 20-year series. For the method yielding the higher productivity, if greater than 75% of the return per spawner values were positive, then that productivity was used in the gap calculation. If less than 75% of these values were positive, the alternate productivity was used.

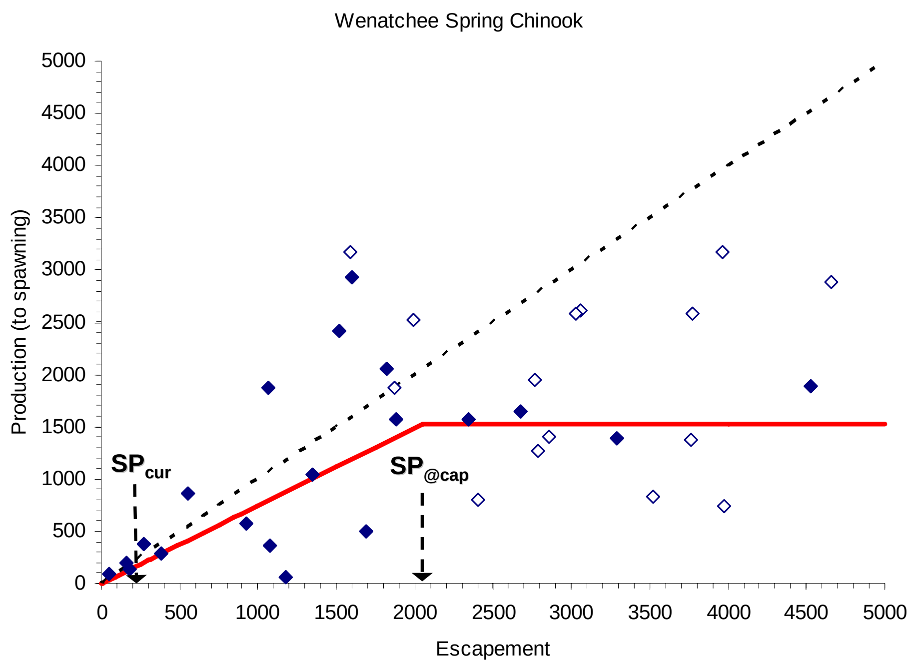


Figure 1. Example of current spawner/spawner relationship (Wenatchee spring Chinook population). Dashed line represents equilibrium replacement. Solid line represents derived stock/recruit function where:. Intrinsic productivity (a = 0.74) calculated from 1978-1999 brood data set (solid diamond symbols); Spawner level at which capacity is reached ($SP_{@cap}$ = 2050) calculated from 1960-99 brood data set (open diamond symbols represent 1960-77 brood data pairs); SPcur = recent 10 year geomean natural escapement. Data compiled in draft ICTRT Wenatchee Spring Chinook Current Status chapter.

Step 2: <u>Spawners at Capacity</u>:

We expanded the stock recruitment data sets for each population to use the full range of available data to determine an estimate of the minimum number of spawners associated with capacity for each population. We used a simple cohort analysis to generate brood year specific estimates of the cumulative number of returns to the spawning grounds. We standardized return rates to reflect recent average SARs and harvest levels in order to remove the large scale variations associated with annual fluctuations in ocean survival rates and trends in harvest rates. The standardized values were calculated by 1) determining the geometric mean SAR and harvest rate for a fixed period (1978-1999 brood years), 2) expressing each brood year SAR and Harvest Rate relative to the corresponding 1978-99 brood year average (1983 through 2004 return years); and 3) calculating adjusted returns as:

$$R_{(t,adj)} = (\sum R_{(t+i)} / (HR_{(t+i,adj))}) / SAR_{(t,adj)}$$

Where: $R_{(t,adj)}$ = Adjusted returns resulting from brood year t spawners
$R_{(t+i)}$ = Returns from brood year t spawners in year t+i, i = 3,4,5,6
$HR_{(t+i,adj)}$ = Expressed as a proportional difference in harvest survival rate = (1 - 1981-2004 HR)/ (1- Estimated Harvest Rate in year t+i)
$SAR_{(t,adj)}$ = Estimated smolt to adult survival rate for brood year t, expressed in proportion to the 1978-99 geomean.

We assumed that the average Lower Granite Dam wild chinook SAR series applied to individual Snake River spring/summer chinook populations. An expansion of the Chiwawa wild production SAR series combined with an index of hatchery smolt survivals was used for Upper Columbia spring chinook populations.

We used the expanded data sets to generate population specific estimates of the minimum spawners at capacity, assuming a Hockey Stick production function. We assumed that the current productivity estimates derived from the 1978-most recent year data sets were the best available estimates given they were derived at relatively low escapements and represent current hydropower and harvest regimes. We incorporated these productivities with the PopTools routine (Excel add-in tool) to ‘fit’ estimates of the number of spawners associated with the breakpoint to constant production (Hockey Stick ‘b’ parameter).

The resulting population specific estimates of spawners at capacity (Hockey Stick ‘b’ parameter) were highly variable. We applied the following approach to reduce the effects of sampling variability on the estimated gaps and to allow for the estimation of capacity for populations with insufficient spawner/recruit information. We grouped populations by species and regressed the estimated capacity against our independently derived estimates of accessible habitat capacity for the subset of populations with sufficient spawner/return data series (Figures 2a & 2b). We did not include populations with substantial habitat degradation and/or chronic large scale hatchery contributions (e.g., Catherine Creek and the Upper Grande Ronde chinook populations) in the regression data sets. For each population we averaged the spawner/return based capacity estimate with the corresponding regression-based estimate to reduce the influence of sampling variation.

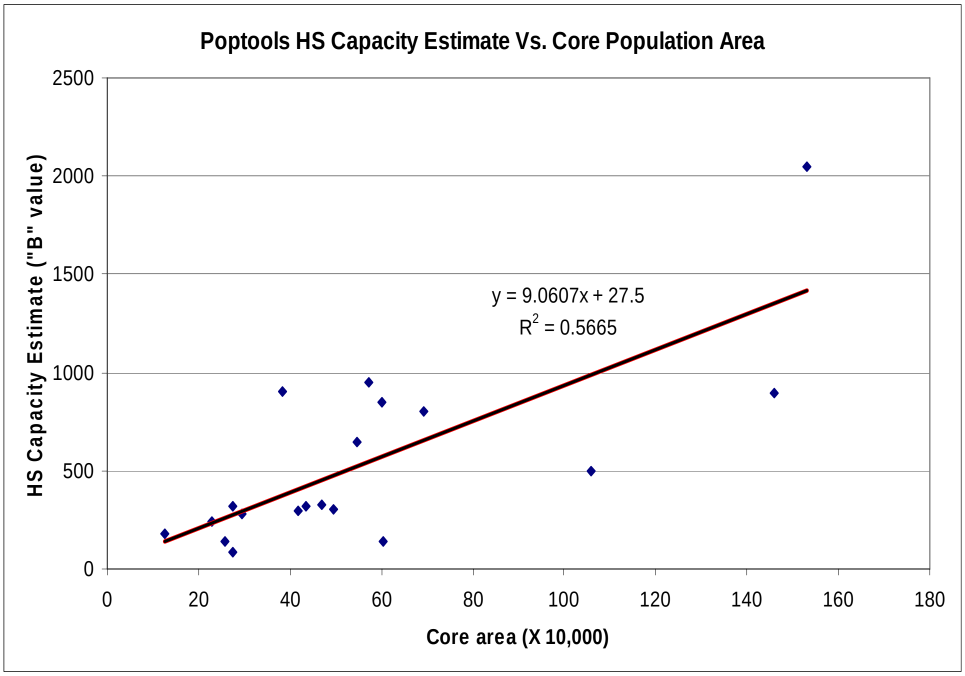


Figure 2a. *Interior Columbia stream type chinook populations. Regression of estimated number of spawners at capacity to available habitat (weighted intrinsic potential).*

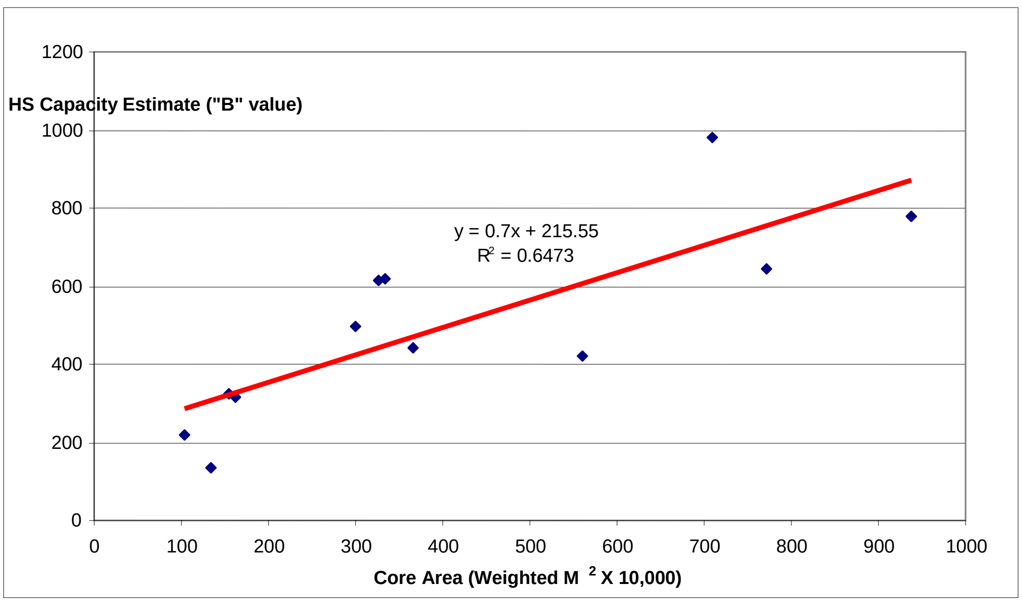
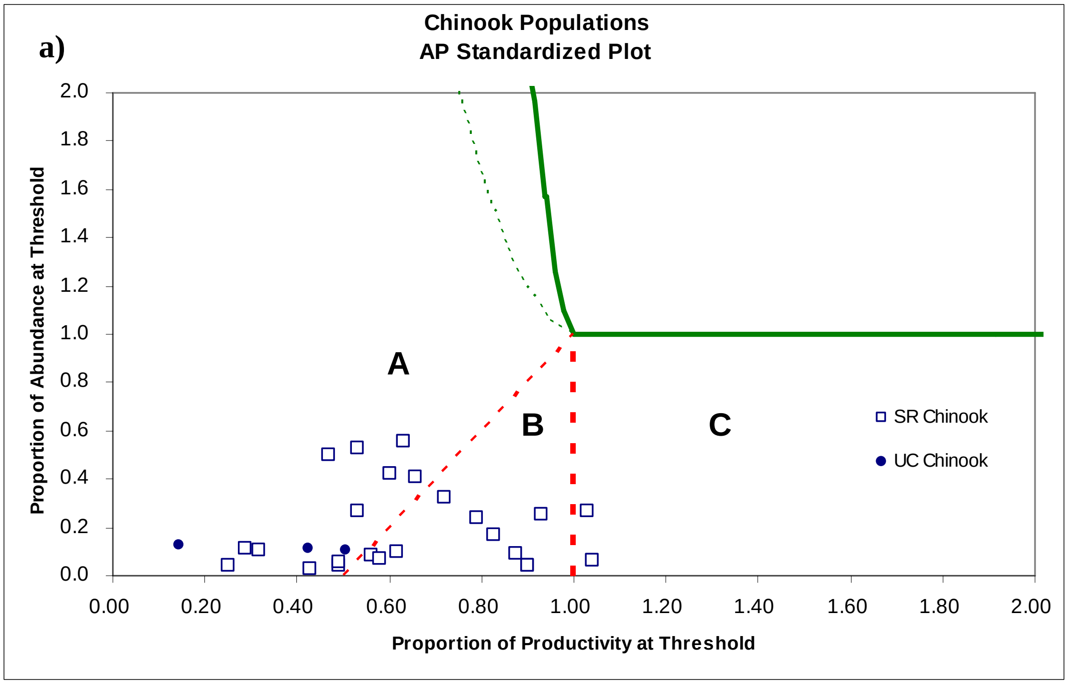


Figure 2b. Interior Columbia steelhead populations. Regression of estimated number of spawners at capacity to available habitat (weighted intrinsic potential).

Step 3: Observed Gaps

We developed a simple approach for expressing the 'distance' from the point defined by the current estimate of abundance and productivity to the corresponding viability curve for each population. We expressed distance in terms of an increase in survival over the life cycle. This allows for a consistent, although relatively coarse scale, initial comparison of the level of action required to meet specific recovery targets across the range of populations within a particular ESU. Many recovery planning actions, if successful, would translate directly into improved survivals for a particular component life stage (e.g., improvements to juvenile summer rearing habitat, downstream smolt migration, or adult holding stage habitat). Other actions may have a more complex linkage to life stage survivals and/or habitat carrying capacities. Importantly, this distance does not target any particular life stages for improvement; more complete limiting factors analyses and life-cycle modeling will be necessary to identify priority actions and life stages.

As a first step, we sorted populations into categories based on their current status relative to the viability curves. We standardized across population size categories (and species) by expressing the population specific current abundance and productivity estimates as a proportion of the applicable threshold abundance and the minimum productivity value associated with the threshold (Figure 3a,b). We divided the surface beneath the curve into three basic zones corresponding to the general characteristics described above (Figure 3a,b). Point estimates falling below and substantially to the left of the transition point on the curve to threshold abundance levels (zone A) have demonstrated a combination of relatively low productivity and abundance over the past 20 years. It is unlikely that density dependent effects are substantially influencing the productivity values for these populations. Point estimates for some populations, primarily from the Mid-Columbia steelhead ESU, fall below their viability curves but substantially to the right of the minimum productivity values associated with the threshold (zone C). It is likely that these population specific estimates are influenced by density dependent effects. Some populations fall in a transition zone between the two general regions described above—they reflect an increasing probability of density dependent effects at higher relative productivity levels (zone B).



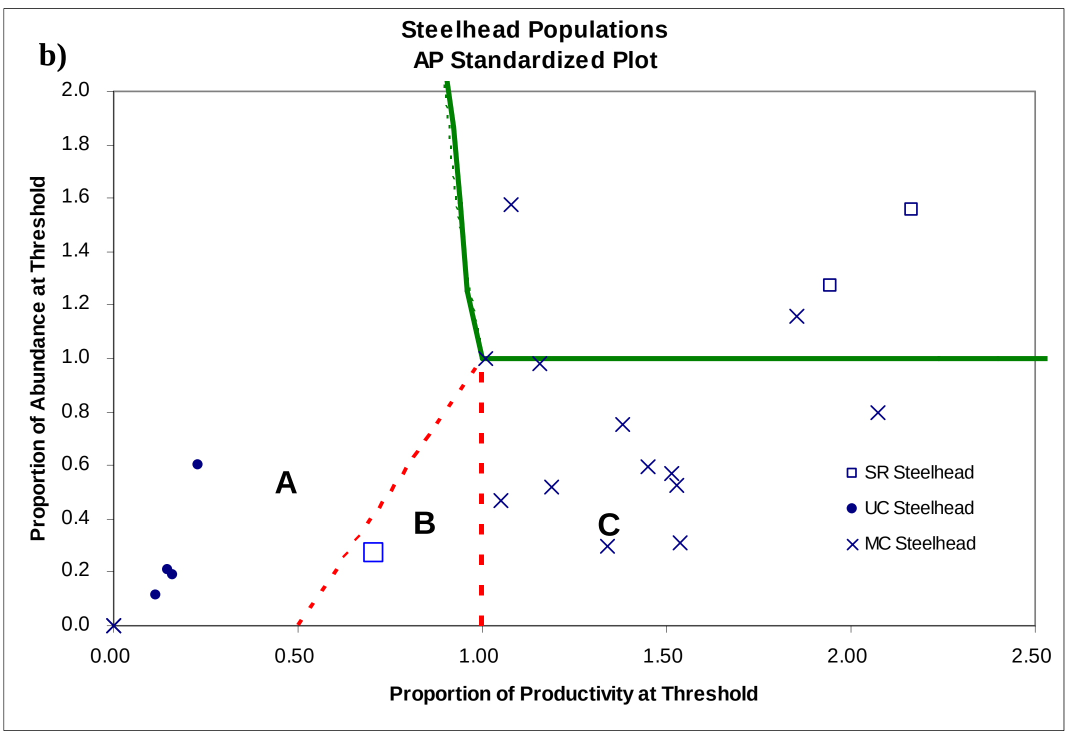


Figure 3a&b: *Current abundance and productivity estimates for Upper Columbia and Snake River yearling type chinook (a) and steelhead (b) populations. Estimates from ICTRT draft Current Status Assessments expressed as proportions. Current abundance relative to the threshold value, productivity relative to the minimum productivity value on the viability curve corresponding to threshold abundance.*

Zone A: Very Low/Low productivity

The right-most boundary for this grouping was defined by a line extending from a relative productivity value of 0.5 on the x axis to the point representing the minimum productivity/threshold combination on the viability curve (relative productivity = 1.0, abundance = threshold level). We estimated the observed survival gap for populations falling to the left of this line by determining the shortest distance from the point defining current status for a particular population to its corresponding viability curve (e.g., Fig. 4). The relative change along the productivity (x) axis was used to define the survival change required for populations in this zone. We included a check to ensure that the capacity required to meet the target level abundance generated by this approach was within a reasonable range: if the target abundance/productivity pair required a number of spawners at capacity exceeding the threshold level, we increased the target productivity to the value on the viability curve corresponding to a spawner capacity equal to the threshold for the population size category.

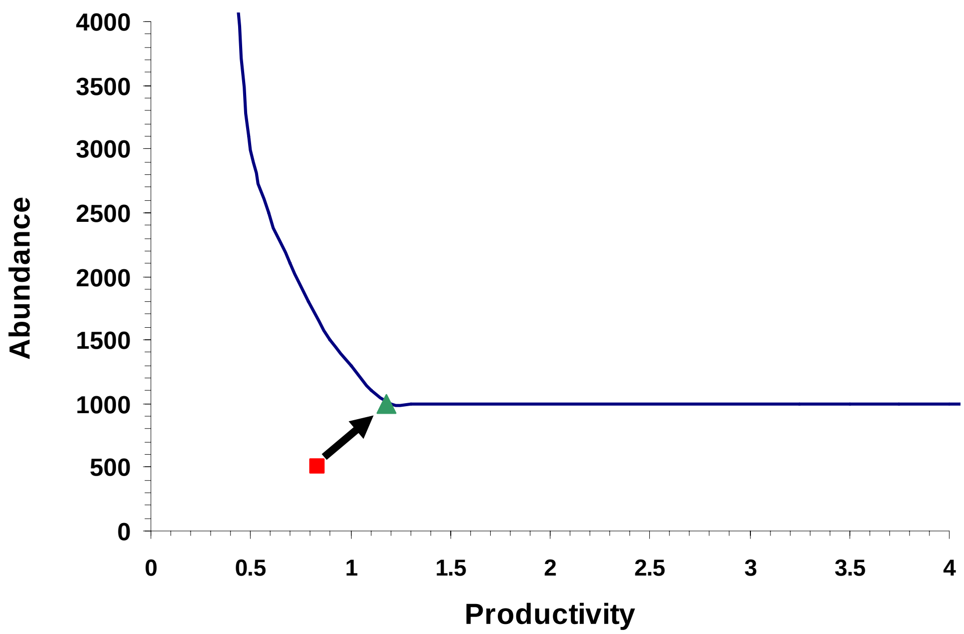


Figure 4. *Illustration of approach for calculating the" zone A" gap between current status (abundance/productivity) and a selected viability curve. This example is a large sized population (minimum abundance threshold of 1000 spawners). The 5% viability curve (line) represents minimum combinations of abundance (at equilibrium) and productivity (expected spawner/spawner ratio from spawning levels below capacity for the population) projecting to no more than a 5% risk of extinction over 100 years. The square represents estimates of current abundance and productivity. The triangle represents combination of abundance and productivity on the viability curve that is the shortest linear distance from the current status point.*

Zone B: Transition zone

Populations with current productivity/abundance estimates plotting out above the upper boundary for zone A but with relative productivities less than 1.0 (i.e., productivity estimate below the minimum associated with the threshold for the particular population size group) were included in this zone. The nearest point on the viability/threshold curve for populations in this category was the inflection associated with threshold abundance. As noted above, the potential for carrying capacity limitations is increased in this zone. Accordingly, we directly incorporated an element in the gap calculations that would increase the survival change needed to achieve recovery objectives to counter the potential dampening effects of capacity limits (see formula in Table 1). We started by calculating proportional change in productivity needed to increase from the current level to the minimum level associated with threshold abundance on the target viability curve. We generated an estimate of current capacity (see description below) and calculated the production associated with spawner capacity (spawners at capacity X current productivity). We substituted the resulting value on the abundance/productivity surface and calculated the minimum distance between that point and the viability/threshold curve. That minimum distance, expressed as a multiplier against current productivity, defines the gap for populations falling within this zone. In most cases the theoretical equilibrium point for populations in this grouping falls below the viability/threshold curve at current productivity levels. In those cases the resulting gap includes an additional survival increment reflecting the need to counterbalance the potential capacity effect.

Table 1. *Equations for calculating relative population survival gaps as a function of current abundance/productivity estimates.*

Zones	Abundance	Productivity	Survival Gap Calculation	Notes
A	Below Threshold	Very Low to Moderate	Survival Gap = $P_{threshold}/P_{current} - 1$	Assume that density dependent effects are secondary at these levels.
B	Below Threshold	Low to Moderate	Survival Gap = $\mathrm{Sqrt}\,(P_{gap}^2 + C_{gap}^2)/(P_{current}/P_{threshold})$	Added gap component reflecting potential capacity limitations
C	Below Threshold	Exceeds minimum at Threshold	Survival Gap = Threshold/ $\mathrm{Avg}\,(EQ_{capacity}, AB_{10\ yr\ gm}) - 1$	Assume strong density dependent effects. Equal weight to calculated equilibrium, recent performance
D	Above Threshold	Exceeds Viability Curve	Negative survival gap = proportion current exceeds viability curve	Focus on risk given uncertainty of productivity estimate.

Zone C: Moderate to High Relative Productivity

Populations in this category have exhibited average productivity values above the minimums associated with threshold abundance levels. However, recent average abundance levels in this zone have been relatively low compared to the corresponding viability curve. We assumed that populations in this category were strongly affected by density dependent factors. The gap estimates for populations in this category were generated based on the estimated shortfalls in observed abundance and estimated capacity relative to the threshold abundance level applicable to that particular population (see formula in Table 1). The resulting gaps are expressed as a proportional increase in productivity, but could potentially also be addressed by increasing the effective capacity of the population.

Zone D: Abundance/Productivity Combination Exceeds Curve

Population level abundance and productivity combinations in this zone exceed the particular viability curve and translate into negative gaps in this analysis. The relative distance below 0.0 reflects the proportional reduction in survival that could occur before that population rating would drop below the target viability curve. Very few populations in the Interior Columbia fall into this category, based on performance over the most recent 20-25 years.

Example Gap Calculations

The gaps are expressed as multipliers against recent life cycle survival rates. We assumed that each population functions according to a Hockey Stick stock production function. As an example for a population in Gap Zone A, for the 1978-98 broods, the estimated intrinsic productivity for the Wenatchee spring chinook population is 0.74, with an estimated capacity of approximately 2050 spawners (Figure 5a).

As described above, the working assumption in estimating gaps for populations falling in zone A is that the capacity for additional spawners is high enough that increasing the populations productivity to the minimum level associated with threshold abundance on the applicable viability curve will be sufficient to meet the criteria. For the Wenatchee, an average survival improvement of 135% (over the life cycle) would be required to elevate the adult stock recruit function to a level that would meet the 5% viability curve (Figure 5a). The resulting productivity/equilibrium abundance would be:

Productivity (adjusted) = 0.74 X (1.0 + 1.35) = 1.74

Equilibrium Escapement (adj) = 1.74 X (.74 X 1,740) = 2,310

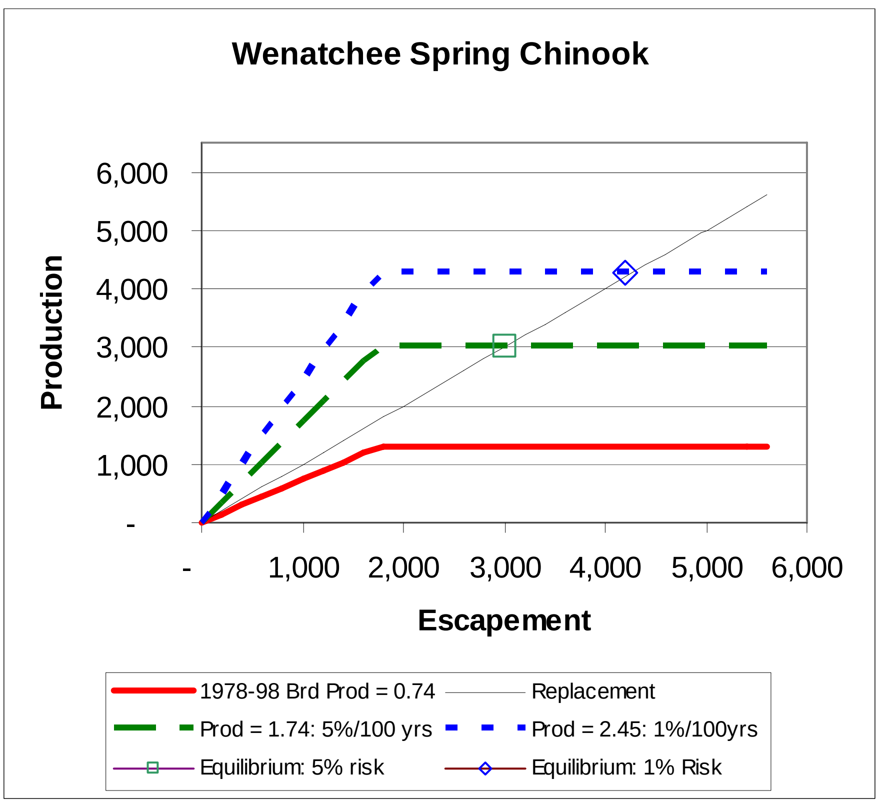


Figure 5a: *Simple Hockey stock models corresponding to base conditions (1978-98 broods), the 5% risk scenario and the 1% risk scenario. Symbols indicate the projected equilibrium escapement levels associated with the required proportional survival increases.*

The second example, using information for the Deschutes (Westside) steelhead population, illustrates the gaps calculation for populations classified in zone C. Populations in this category have recent average abundances below minimum thresholds, although their current productivities exceed the minimum value associated with threshold abundance on the corresponding viability curve. Gaps calculated for populations in falling into zone C are based on the assumption that changes in productivity or capacity could contribute to elevating the status of the population relative to the viability curve.

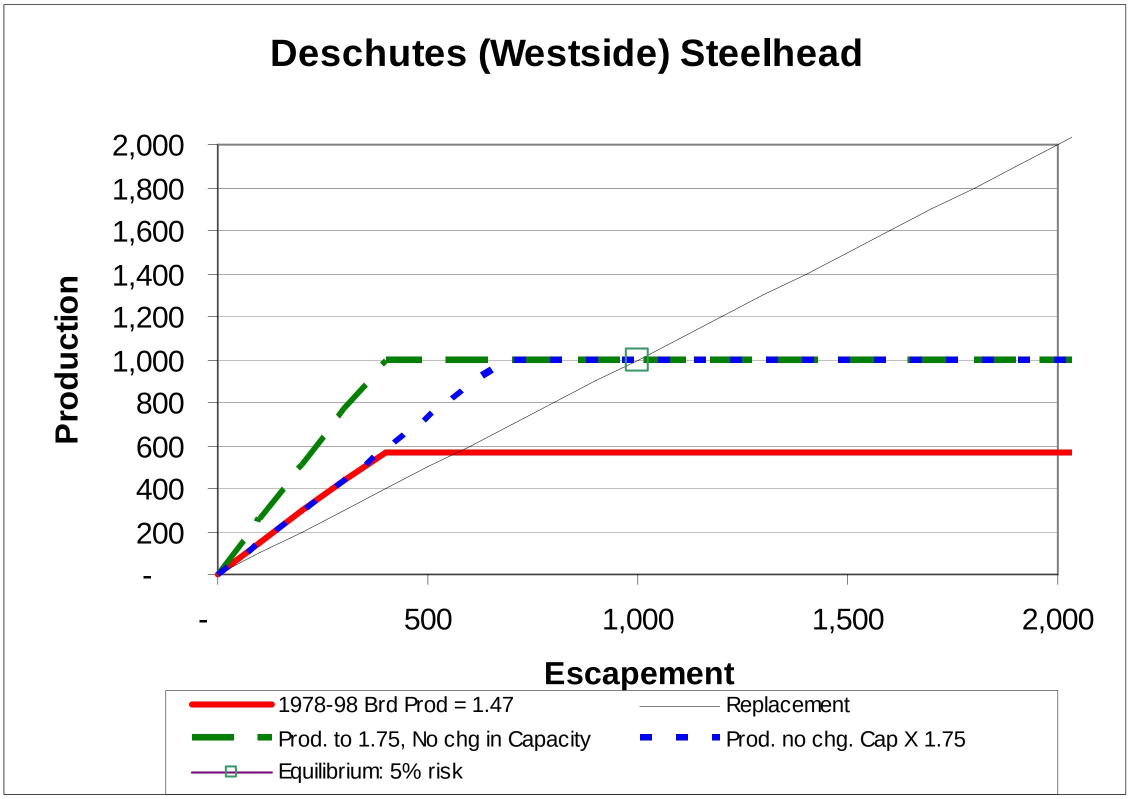


Figure 5b*: Simple Hockey stock models illustrating base conditions (1978-98 broods), the 5% risk scenario achieved through increased productivity, and the 5% risk scenario achieved through increase in habitat capacity.*

We calculated gaps for these populations based on the proportional improvement in equilibrium abundance required to exceed the threshold. The following equations illustrate the gap calculations for zone C type populations. Equilibrium capacity estimates based on curve fits to relatively limited data sets can have high uncertainty levels. We incorporated alternative estimates into the gap calculations in order to reduce the impact of sampling variation.

As a first step, we averaged the direct estimate of the minimum number of spawners associated with capacity/equilibrium with a second estimate generated using a simple regression model. The regression incorporated estimates of spawners at capacity and corresponding estimates of the quantity of available spawning habitat for all populations in the analysis. The resulting estimate for Deschutes (Westside) steelhead population was 457 spawners.

Step 2 in the calculation of gaps for the zone C type populations requires multiplying the current productivity against the estimated spawners at capacity to generate an estimate of equilibrium abundance.

$$\text{Cap (current)} = \text{Spawners at capacity(avg)} * \text{Productivity}$$

$$= 457 \times 1.47$$

$$= 672$$

We assumed that recent 10 year geomean abundance also represented an estimate of equilibrium abundance for zone C type populations. For the Deschutes (Westside) steelhead population the recent 10 year geomean abundance was 470 spawners and the average of the two estimates was 571 spawners.

The third and final step in calculating a quantitative gap estimate for a zone C type population is to express the capacity estimated in step 2 relative to the threshold abundance level for the population.

$$\begin{aligned} \text{Gap} &= \text{Threshold} / \text{Cap(current)} - 1. \\ &= 1{,}000 / 571 - 1 \\ &= 0.75 \end{aligned}$$

Two different viability scenarios for Deschutes(Westside)steelhead are illustrated in Figure 5b. Under one strategy, the gap would be addressed by improvements in productivity achieved through increases in life stage survivals. Alternatively, a combination of abundance and productivity exceeding the 5% viability curve could be achieved by increases in functional spawner capacity. Combinations of improvements in survival and capacity could also meet the viability objectives.

Considering Parameter Uncertainty

One of the main tasks assigned to each of the regional Technical Recovery Teams is to develop criteria for use in assessing the status of listed ESUs. The ICTRT has proposed a set of biologically based criteria for use in judging the relative status of a particular listed ESU, based on the current status of its component populations. As a result of the high year to year variability in survival rates and inherent uncertainties in key biological assumptions, the abundance/productivity elements of a population assessment require evaluating performance over a substantial period of time—a minimum of 15-20 years for most populations. The ICTRT has developed some options for dealing with relatively high levels of uncertainty that can be associated with point estimates of abundance and productivity for policy consideration (ICTRT, 2005b). Those methods were specifically designed to be used in assessing status at a particular point in time - looking at performance over a recent 20 period for example. However, the same methods can be adapted for planning purposes to illustrate the potential need for 'buffering' expected survival changes to reflect parameter uncertainties. The following examples illustrate the use of one of the optional buffering methods. Applying this approach for planning purposes requires the assumption that the future magnitude of uncertainty in productivity will be similar to current estimates (expressed here as sample standard error).

In some cases the standard errors for current population productivity estimates were high, leading to a substantial probability that the actual underlying risk level exceeded 25% in 100 years. We identified those situations and adapted one of the alternative uncertainty buffers (Dec. ICTRT Viability Update memo; alternative B1) to adjusted observed gaps.

We chose two populations to represent the range in uncertainty at relatively low productivity. The Imnaha spring chinook data set (productivity SE of 0.12) represents populations with relatively low statistical uncertainty about the geomean productivity estimate. Deschutes (Eastside) steelhead, with a standard error of 0.31, represents the high end of the range. We generated a set of graphs for each population (Figs. 6 & 7).

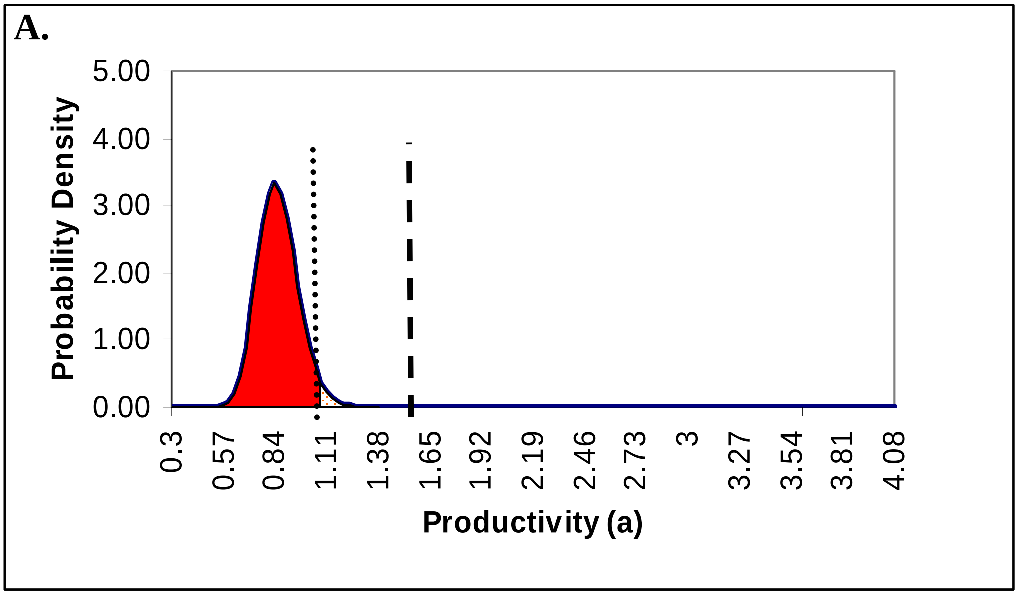
The curved line in each figure represents the probability distribution of the estimated geomean return/spawner at low to moderate abundance. The distribution was generated using the excel function NORMINV. We assumed that error distribution was lognormal and used the calculated geomean and standard error for each population data series. We did not specifically allocate any of the variability to measurement error.

We simplified the target productivity/abundance combinations to illustrate the potential effect of incorporating an uncertainty buffer in calculating gaps. The minimum average productivity values highlighted on each graph (Fig. 6) as a vertical dashed line correspond to the lowest productivity associated with threshold abundance. The dotted vertical line on each graph represents the productivity associated with a recent average abundance at the threshold level and a 100 year risk of 25%. The relative proportion of the distribution to the left of a particular line represents the probability that the 'true' productivity is less than the value represented by the vertical line.

The distribution depicted in the first graph in each set represents current status (Figs. 6a & 7a). The distribution in the second graph represents an increase from the current average productivity to the level just meeting the 5% risk objective, assuming the current standard error would still reflect the uncertainty level (Figs. 6b & 7b). Since the Deschutes (Eastside) population exceeds the 5% risk curve criteria at current level, for this population the second graphic represents the minimum productivity estimate associated with the threshold (Figure 7b). The third graph in the Deschutes (Eastside) steelhead set represents an additional incremental improvement in productivity sufficient to meet the uncertainty buffer test - no less than a 1 in 20 chance that the 'true' productivity value is less than the level corresponding to a 25% risk of extinction in 100 years (Figure 7c).

The Imnaha River population would need a 88% increase over current levels to meet the 5% risk viability curve. Assuming that the standard error associated with estimated productivity remains at 0.19, the increase to get geomean productivity to the 5% curve The test incorporating relative uncertainty indicates that with that increase the probability that the actual productivity value is associated with a 25% risk of extinction or greater is less than 1 in 20. In this case, no increase over the basic gap analysis would be required.

The basic gaps analysis indicates that the current point estimate of productivity for the Deschutes (Eastside) population exceeds the required level to meet the 5% risk test. However, given the relatively broad error bounds on this estimate, productivity would need to be increased by 14% to reduce the chances to less than 1 in 20 that the actual risk is greater than 25% in 100 years.



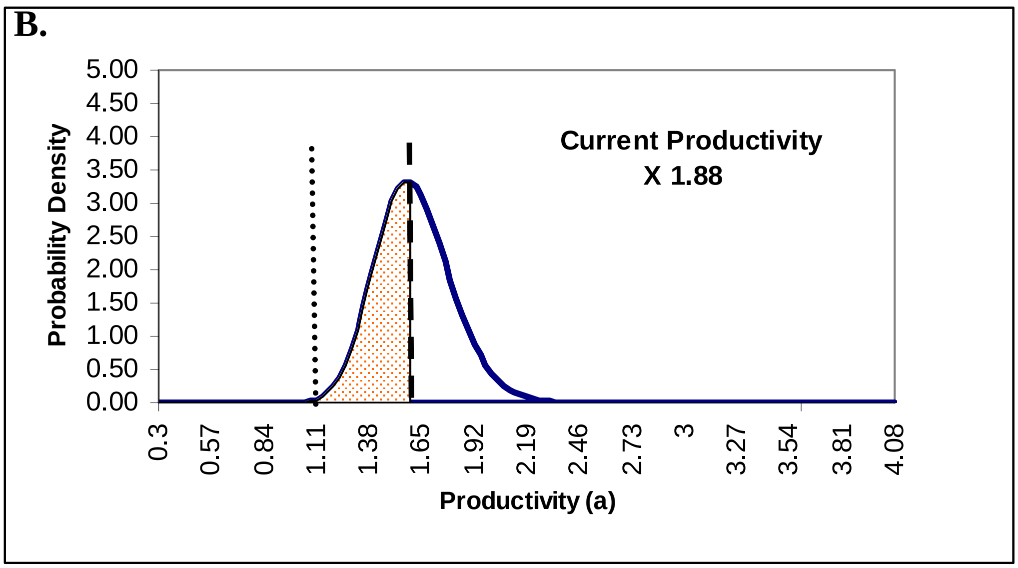


Figure 6. *Example #1: Low standard error data series. Probability distribution of estimated productivity for Imnaha Spring Chinook Population. A) geomean and distribution (SE =0 .19) relative to productivities corresponding to 25% and 5% risk levels at threshold abundance. B) With productivity increased to meet 5% risk at threshold abundance. Solid filled area represents probability that the 'true' productivity is low enough that A/P risk rating would be High (exceeds 25% in 100 years). Light shaded area represents probability that the 'true' productivity is at a level corresponding to a Moderate A/P rating. Clear area under the curve represents probability that risk rating is Low.*

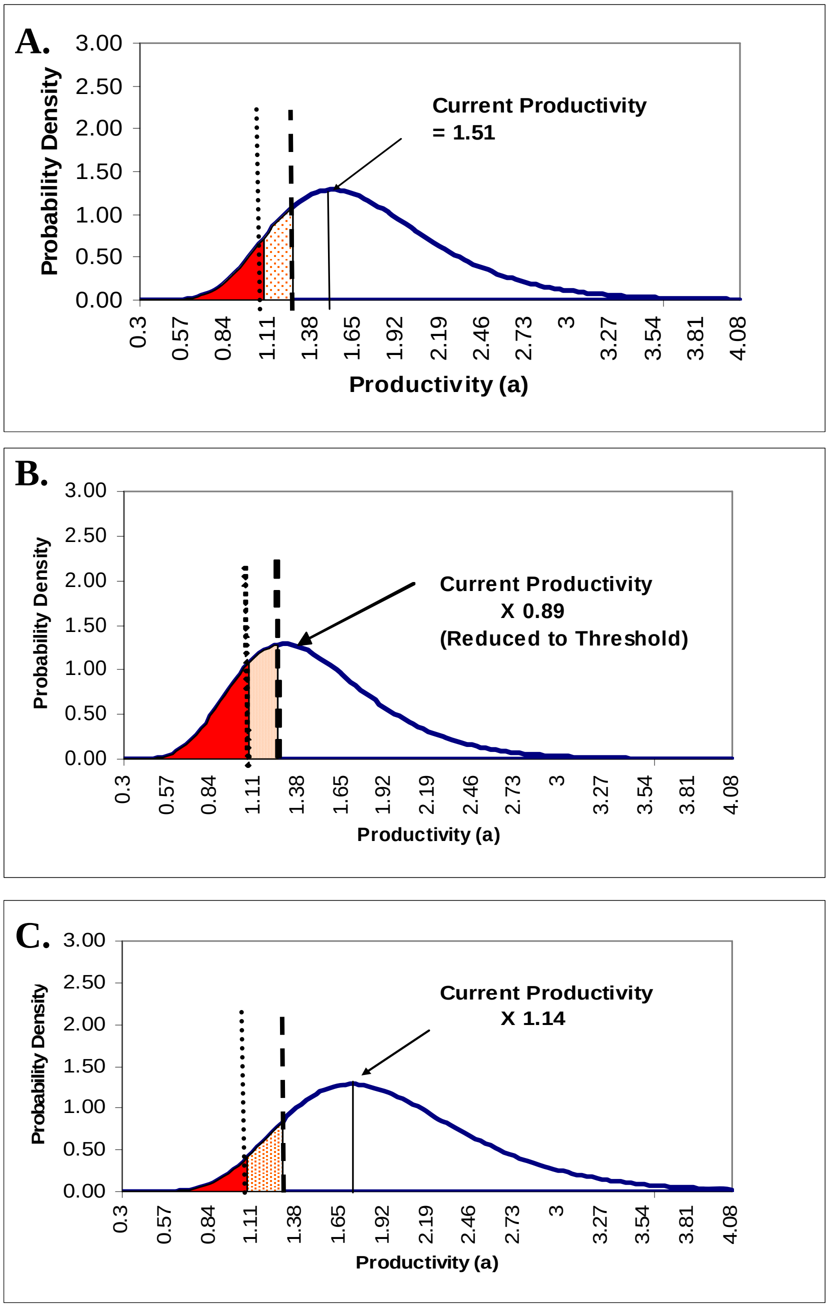


Figure 7. *Example #2: High standard error data series. Probability distribution of estimated productivity for the Deschutes (Eastside) Steelhead population. A) geomean and distribution (SE =0 .31) relative to productivities corresponding to 25% and 5% risk levels at threshold abundance. B) Productivity DECREASED to minimum for 5% risk criteria. C.)INCREASE from base productivity to reduce the probability to less than 1 in 20 that the actual risk level exceeds 25% in 100 years. . Solid filled area represents probability that the 'true' A/P risk rating would be High (exceeds 25% in 100 years). Light shaded area represents probability that the 'true' A/P risk is Moderate (5-25%). Clear area under the curve represents probability that risk rating is Low.*

Calculations Summary

The following tables include the population specific input data, calculation step results and Observed Gap estimates (relative to 1%, 5% and 25% risk viability curves). The last columns in these tables are the population specific Observed Gap estimates carried over and discussed by ESU in the ICTRT Interim Gaps Report (ICTRT, 2006b).

Table Column Contents

1. *10 yr Geomean Abund*.: Geomean (most recent 10 years) of natural origin spawners in natural spawning areas (from population specific Current Status Assessments).
2. *20 yr. Productivity*: Geomean productivity at low to moderate total spawning numbers.
3. *Productivity SE*: standard error of the mean (natural log) Productivity estimate for the population.
4. *SE multiplier (0.95)* : Multiplier (upper critical value from t distribution corresponding to sample size n) to Productivity SE, used in calculating productivity value at the lower 5% confidence bound (1 tailed test).
5. *SE multiplier (0.99)*: Multiplier (upper critical value from t distribution corresponding to sample size n) to Productivity SE, used in calculating productivity value at the lower 5% confidence bound (1 tailed test).
6. *Threshold*: Minimum abundance level corresponding to the corresponding population size category (based on historical intrinsic potential habitat).
7. *Averaged Capacity Estimate*: Average of specific estimate derived for population and an estimated generated from regression of capacity vs. historical weighted intrinsic potential habitat.
8. *Average Equilibrium Spawners (Current):* Expected average maximum adult natural return level. For populations with *productivity* above 1.0, is equivalent to estimated equilibrium spawning level.
9. *Gap Zone*: Assigned Gap zone based on abundance and productivity relative to the corresponding population abundance/productivity viability curve (see Fig. 3).
10. *Abundance Prop. of Threshold*: Current natural abundance expressed as a proportion of the corresponding population threshold.
11. *Abund. Needed*: The abundance on the Viability curve associated with *Min. Productivity @ Threshold* (Tables 2a and 3a only).
12. *Prod. at Curve*: (Tables 2a and 3a only). Productivity at closest point on the 25% viability curve relative to the current abundance/productivity for a specific population.
13. *Min. Productivity @ Threshold*: (1% and 5% Risk tables only) The minimum productivity value on the Viability curve associated with the population's size threshold.
14. *Min. Prod. @ Current Abund*.: Used in calculating negative gap where current abundance estimate exceeds the threshold (zone D only)—this is the minimum productivity value associated with the current abundance estimate (Tables 2b, 2c, 3b, and 3c only).
15. *Abundance Check*: Calculated as a check that the capacity required to meet the target level abundance generated by this approach is within a reasonable range relative to the amount of available tributary habitat (Tables 2b, 2c, 3b, and 3c only).
16. *Prod. Gap*: Refers to the gap between current productivity and *Min. Prod. @ Threshold*. This is the gap reported for zone A populations (Tables 2b, 2c, 3b, and 3c only).
17. *Capacity Adjusted Productivity Gap*: Used in zone B populations where the gap reflects the combined effect of capacity and productivity shortfalls (Tables 2b, 2c, 3b, and 3c only).
18. *Observed Gap*: Proportional change in survival required to meet or exceed viability curve for the corresponding risk level (1%, 5%, 25% risk in 100 years).

Table 2. Chinook population gaps to the 25% risk curve (A), 5% risk curve (B), and 1% risk curve (C).

A.

Chinook Populations	Population Statistics										25% Gap		
	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Abund. Needed	Prod. @ Curve	Observed 25% Gap
Tucannon River	177	1.25	0.17	1.75	2.6	750	370	320	**B**	0.24	440	1.31	**0.05**
Asotin Creek	Functionally Extirpated												
Catherine Creek	80	0.50	0.23	1.75	2.58	750	1221	345	**A**	0.11	877	1.06	**1.12**
Lostine River	266	0.76	0.22	1.73	2.54	1000	743	415	**A**	0.27	761	1.1	**0.45**
Minam River	337	1.02	0.21	1.73	2.55	750	351	348	**A**	0.45	646	1.14	**0.12**
Imnaha River	395	0.84	0.12	1.83	2.82	750	1116	666	**A**	0.53	787	1.09	**0.30**
Wenaha River	376	0.74	0.19	1.74	2.57	750	638	424	**A**	0.50	846	1.07	**0.45**
Upper Grande Ronde	40	0.33	0.25	1.73	2.55	1000	1049	193	**A**	0.04	877	1.06	**2.21**
Big Sheep Creek	4	0.29	0.44	1.75	2.58	500							
Lookingglass Creek	Functionally Extirpated												
South Fork Mainstem	556	1.12	0.18	1.78	2.68	1000	584	605	**B**	0.56	816	1.08	**-0.04**
Secesh River	304	1.04	0.13	1.73	2.54	750	392	356	**A**	0.41	646	1.14	**0.10**
East Fork Johnson	321	1.03	0.21	1.75	2.58	1000	747	545	**B**	0.32	646	1.14	**0.11**
Little Salmon River	Insufficient Data												
Big Creek	94	1.25	0.20	1.73	2.54	1000	358	271	**B**	0.09	431	1.32	**0.06**
Bear Valley Creek	188	1.47	0.18	1.73	2.55	750	391	381	**B**	0.25	335	1.49	**0.01**
Marsh Creek	42	1.05	0.21	1.73	2.55	500	240	147	**B**	0.08	566	1.2	**0.14**
Sulphur Creek	21	0.92	0.36	1.75	2.58	500	161	85	**A**	0.04	646	1.14	**0.24**
Camas Creek	29	0.92	0.29	1.74	2.57	500	202	107	**A**	0.06	646	1.14	**0.24**
Loon Creek	51	1.15	0.31	1.75	2.58	500	182	130	**A**	0.10	481	1.27	**0.10**
Chamberlain Creek	223	2.09	0.46	1.89	3.00	500							
Lower Middle Fork Salmon	Insufficient Data												
Upper Middle Fork Salmon	Insufficient Data												
Lemhi River	80	1.08	0.26	1.72	2.53	2000	872	511	**B**	0.04	542	1.22	**0.13**
Valley Creek	35	1.08	0.24	1.73	2.55	500	296	177	**B**	0.07	530	1.23	**0.14**
Yankee Fork	13	0.80	0.31	1.77	2.65	500	348	146	**A**	0.03	646	1.14	**0.43**
Upper Salmon River	268	1.47	0.21	1.73	2.53	1000	730	671	**C**	0.27	340	1.48	**0.01**
North Fork Salmon River	Insufficient Data												
Lower Salmon River	123	1.25	0.18	1.72	2.53	2000	750	530	**C**	0.06	440	1.31	**0.05**
East Fork Salmon River	169	1.18	0.25	1.72	2.53	1000	747	525	**B**	0.17	481	1.27	**0.08**
Pahsimeroi River	112	0.41	0.39	1.75	2.58	1000	752	210	**A**	0.11	877	1.06	**1.59**
Panther Creek	Functionally Extirpated												
Fall Chinook 1977-	1273	0.95	0.14	1.72	2.53	3000	2400	1777	**B**	0.42	1448	1.12	**0.18**
Fall Chinook 1990-	1273	1.24	0.15			3000	2380	2112	**B**	0.42	1261	1.15	**0.00**
Wenatchee	226	0.74	0.31	1.80	2.72	2000	1797	778	**A**	0.11	1073	1.35	**0.82**
Methow	205	0.88	0.22	1.75	2.58	2000	1186	624	**A**	0.10	963	1.39	**0.58**
Entiat	63	0.72	0.15	1.72	2.53	500	290	136	**A**	0.13	1016	1.37	**0.90**

B.

Chinook Populations	Population Statistics										5% Gap					
	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Min. Prod. @ Threshold	Min. Prod. @ Current Abund.	Abundance Check	Prod. Gap	Capacity Adjusted Productivity Gap	Observed 5% Gap
Tucannon River	177	1.25	0.17	1.75	2.60	750	370	320	**B**	0.24	1.58		0.58	0.26	0.55	**0.55**
Asotin Creek	Functionally Extirpated															
Catherine Creek	80	0.50	0.23	1.75	2.58	750	1221	345	**A**	0.11	1.58		0.00	2.16		**2.16**
Lostine River	266	0.76	0.22	1.73	2.54	1000	743	415	**A**	0.27	1.43		0.06	0.88		**0.88**
Minam River	337	1.02	0.21	1.73	2.55	750	351	348	**A**	0.45	1.58		0.29	0.55		**0.55**
Imnaha River	395	0.84	0.12	1.83	2.82	750	1116	666	**A**	0.53	1.58		0.06	0.88		**0.88**
Wenaha River	376	0.74	0.19	1.74	2.57	750	638	424	**A**	0.50	1.58		0.00	1.14		**1.14**
Upper Grande Ronde	40	0.33	0.25	1.73	2.55	1000	1049	193	**A**	0.04	1.43		0.00	3.33		**3.33**
Big Sheep Creek	4	0.29	0.44	1.75	2.58	500										
Lookingglass Creek	Functionally Extirpated															
South Fork Mainstem	556	1.12	0.18	1.78	2.68	1000	584	605	**B**	0.56	1.43		0.57	0.28	0.52	**0.52**
Secesh River	304	1.04	0.13	1.73	2.54	750	392	356	**A**	0.41	1.58		0.32	0.52		**0.52**
East Fork Johnson	321	1.03	0.21	1.75	2.58	1000	747	545	**B**	0.32	1.43		0.44	0.39	0.50	**0.50**
Little Salmon River	Insufficient Data															
Big Creek	94	1.25	0.20	1.73	2.54	1000	358	271	**B**	0.09	1.43		0.75	0.14	0.65	**0.65**
Bear Valley Creek	188	1.47	0.18	1.73	2.55	750	391	381	**B**	0.25	1.58		0.86	0.07	0.26	**0.26**
Marsh Creek	42	1.05	0.21	1.73	2.55	500	240	147	**B**	0.08	1.87		0.12	0.78	1.18	**1.18**
Sulphur Creek	21	0.92	0.36	1.75	2.58	500	161	85	**A**	0.04	1.87		0.00	1.03		**1.03**
Camas Creek	29	0.92	0.29	1.74	2.57	500	202	107	**A**	0.06	1.87		0.00	1.03		**1.03**
Loon Creek	51	1.15	0.31	1.75	2.58	500	182	130	**A**	0.10	1.87					
Chamberlain Creek	223	2.09	0.46	1.89	3.00	500										
Lower Middle Fork Salmon	Insufficient Data															
Upper Middle Fork Salmon	Insufficient Data															
Lemhi River	80	1.08	0.26	1.72	2.53	2000	872	511	**B**	0.04	1.20		0.80	0.11	0.60	**0.60**
Valley Creek	35	1.08	0.24	1.73	2.55	500	296	177	**B**	0.07	1.87		0.16	0.73	0.96	**0.96**
Yankee Fork	13	0.80	0.31	1.77	2.65	500	348	146	**A**	0.03	1.87		0.00	1.34		**1.34**
Upper Salmon River	268	1.47	0.21	1.73	2.53	1000	730	671	**C**	0.27	1.43		1.06	-0.03		**0.49**
North Fork Salmon River	Insufficient Data															
Lower Salmon River	123	1.25	0.18	1.72	2.53	2000	750	530	**C**	0.06	1.20		1.08	-0.04		**2.77**
East Fork Salmon River	169	1.18	0.25	1.72	2.53	1000	747	525	**B**	0.17	1.43		0.65	0.21	0.26	**0.26**
Pahsimeroi River	112	0.41	0.39	1.75	2.58	1000	752	210	**A**	0.11	1.43		0.00	2.49		**2.49**
Panther Creek	Functionally Extirpated			0.00	0.00											
Fall Chinook 77-present	1273	0.95	0.14	1.72	2.53	3000	2400	1777	**B**	0.42	1.28		0.48	0.35	0.47	**0.47**
Fall Chinook 90-present	1273	1.24	0.15	0.00	0.00	3000	2380	2112	**B**	0.42	1.28		0.94	0.03	0.04	**0.04**
Wenatchee	226	0.74	0.31	1.80	2.72	2000	1797	778	**A**	0.11	1.74		0.00	1.35		**1.35**
Methow	205	0.88	0.22	1.75	2.58	2000	1186	624	**A**	0.10	1.74		0.01	0.98		**0.98**
Entiat	63	0.72	0.15	1.72	2.53	500	290	136	**A**	0.13	1.84		0.00	1.56		**1.56**

C.	Population Statistics										1% Gap					
Chinook Populations	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Min. Prod. @ Threshold	Min. Prod. @ Current Abund.	Abundance Check	Prod. Gap	Capacity Adjusted Productivity Gap	Observed 1% Gap
Tucannon River	177	1.25	0.17	1.75	2.60	750	370	320	**B**	0.24	2.10		0.19	0.68	0.94	**0.94**
Asotin Creek	Functionally Extirpated															
Catherine Creek	80	0.50	0.23	1.75	2.58	750	1221	345	**A**	0.11	2.10		0.00	3.20		**3.20**
Lostine River	266	0.76	0.22	1.73	2.54	1000	743	415	**A**	0.27	1.85		0.00	1.43		**1.43**
Minam River	337	1.02	0.21	1.73	2.55	750	351	348	**A**	0.45	2.10		0.00	1.06		**1.06**
Imnaha River	395	0.84	0.12	1.83	2.82	750	1116	666	**A**	0.53	2.10		0.00	1.50		**1.50**
Wenaha River	376	0.74	0.19	1.74	2.57	750	638	424	**A**	0.50	2.10		0.00	1.84		**1.84**
Upper Grande Ronde	40	0.33	0.25	1.73	2.55	1000	1049	193	**A**	0.04	1.85		0.00	4.61		**4.61**
Big Sheep Creek	4	0.29	0.44	1.75	2.58	500										
Lookingglass Creek	Functionally Extirpated															
South Fork Mainstem	556	1.12	0.18	1.78	2.68	1000	584	605	**B**	0.56	1.85		0.21	0.65	0.87	**0.87**
Secesh River	304	1.04	0.13	1.73	2.54	750	392	356	**A**	0.41	2.10		0.00	1.02		**1.02**
East Fork Johnson	321	1.03	0.21	1.75	2.58	1000	747	545	**B**	0.32	1.85		0.11	0.80	0.90	**0.90**
Little Salmon River	Insufficient Data															
Big Creek	94	1.25	0.20	1.73	2.54	1000	358	271	**B**	0.09	1.85		0.35	0.48	0.95	**0.95**
Bear Valley Creek	188	1.47	0.18	1.73	2.55	750	391	381	**B**	0.25	2.10		0.40	0.43	0.54	**0.54**
Marsh Creek	42	1.05	0.21	1.73	2.55	500	240	147	**B**	0.08	3.10		0.00	1.95	2.44	**2.44**
Sulphur Creek	21	0.92	0.36	1.75	2.58	500	161	85	**A**	0.04	3.10		0.00	2.37		**2.37**
Camas Creek	29	0.92	0.29	1.74	2.57	500	202	107	**A**	0.06	3.10		0.00	2.37		**2.37**
Loon Creek	51	1.15	0.31	1.75	2.58	500	182	130	**A**	0.10	3.10		0.00	1.70		**1.70**
Chamberlain Creek	223	2.09	0.46	1.89	3.00	500										
Lower Middle Fork Salmon	Insufficient Data															
Upper Middle Fork Salmon	Insufficient Data															
Lemhi River	80	1.08	0.26	1.72	2.53	2000	872	511	**B**	0.04	1.48		0.46	0.37	0.81	**0.81**
Valley Creek	35	1.08	0.24	1.73	2.55	500	296	177	**B**	0.07	3.10		0.00	1.87	2.14	**2.14**
Yankee Fork	13	0.80	0.31	1.77	2.65	500	348	146	**A**	0.03	3.10		0.00	2.88		**2.88**
Upper Salmon River	268	1.47	0.21	1.73	2.53	1000	730	671	**C**	0.27	1.85		0.59	0.26		**0.49**
North Fork Salmon River	Insufficient Data															
Lower Salmon River	123	1.25	0.18	1.72	2.53	2000	750	530	**C**	0.06	1.48		0.69	0.18		**2.77**
East Fork Salmon River	169	1.18	0.25	1.72	2.53	1000	747	525	**B**	0.17	1.85		0.28	0.57	0.60	**0.60**
Pahsimeroi River	112	0.41	0.39	1.75	2.58	1000	752	210	**A**	0.11	1.85		0.00	3.51		**3.51**
Panther Creek	Functionally Extirpated			0.00	0.00											
Fall Chinook 77-present	1273	0.95	0.14	1.72	2.53	3000	2400	1777	**B**	0.42	1.50		0.27	0.58	0.69	**0.69**
Fall Chinook 90-present	1273	1.24	0.15	0.00	0.00	3000	2380	2112	**B**	0.42	1.50		0.65	0.21	0.21	**0.21**
Wenatchee	226	0.74	0.31	1.80	2.72	2000	1797	778	**A**	0.11	2.45		0.00	2.31		**2.31**
Methow	205	0.88	0.22	1.75	2.58	2000	1186	624	**A**	0.10	2.45		0.00	1.78		**1.78**
Entiat	63	0.72	0.15	1.72	2.53	500	290	136	**A**	0.13	2.4		0.00	2.33		**2.33**

Table 3. Steelhead population gaps to the 25% risk curve (A), 5% risk curve (B), and 1% risk curve (C).

A.	Population Statistics										25% Gap		
Steelhead Populations	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Abund. Needed	Prod. @ Curve	Observed 25% Gap
Wenatchee (hatch=1)	900	0.3	0.39	1.81	2.76	1500	4204	1081	**A**	0.60	1267	1.07	**2.57**
Wenatchee (hatch=0.31)	900	0.65	0.39	1.81	2.76	1500	4204	1081	**A**	0.60	1267	1.07	**0.65**
Methow (hatch=1)	309	0.19	0.63	2.02	3.36	1500	1300	278	**A**	0.21	995	1.1	**4.79**
Entiat (hatch=1)	94	0.26	0.35	1.80	2.72	500	229	77	**A**	0.19	820	1.13	**3.35**
Okanogan (hatch=1)	114	0.16	0.42	1.86	2.9	1000	406	89	**A**	0.11	941	1.11	**5.94**
Deschutes (westside)	470	1.47	0.14	1.81	2.76	1000	457	571	**C**	0.47	302	1.44	**-0.02**
Deschutes (eastside)	1579	1.51	0.31	2.02	3.36	1000	1139	1649	**D**	1.58	1439	1.06	**-0.30**
Klickitat River						1500							
Fifteenmile Creek	593	2.03	0.22	1.86	2.9	1000	323	624	**C**	0.59	186	2	**-0.01**
Rock Creek	Insufficient Data					500							
White Salmon	Functionally Extirpated					1000							
Upper Yakima River	92	1.09	0.12	1.89	3	2250					514	1.23	**0.13**
Naches River	462	2.00	0.16	1.89	3	1500	515	746	**C**	0.31	186	2	**0.00**
Toppenish River	148	2.20	0.20	1.89	3	500	223	319	**C**	0.30	174	2.2	**0.00**
Satus Creek	568	2.12	0.14	1.86	2.9	1000	324	627	**C**	0.57	181	2.10	**-0.01**
John Day Lower Mainstem	1800	2.59	0.18	1.80	2.72	2250	825	1969	**C**	0.80	1439	1.06	**-0.59**
John Day North Fork	1740	2.41	0.22	1.81	2.76	1500	700	1713	**D**	1.16	1439	1.06	**-0.56**
John Day Upper Mainstem	524	2.14	0.33	1.89	3	1000	528	827	**C**	0.52	181	2.1	**-0.02**
John Day Middle Fork	756	1.93	0.18	1.81	2.76	1000	461	823	**C**	0.76	189	1.92	**-0.01**
John Day South Fork	259	1.95	0.25	1.81	2.76	500	254	378	**C**	0.52	187	1.93	**-0.01**
Umatilla River	1472	1.50	0.15	1.81	2.76	1500	846	1370	**C**	0.98	1439	1.06	**-0.29**
Walla Walla Mainstem	1003	1.41	0.61	2.92	6.96	1000	533	878	**D**	1.00	956	1.12	**-0.21**
Touchet River	Insufficient Data					1000							
Willow Creek	Functionally Extirpated					1000							
Tucannon River	Insufficient Data												
Asotin River	Insufficient Data												
Grande Ronde Upper Main.	1832	2.29	0.18	1.83	2.82	1500	791	1822	**D**	1.22	1600	0.95	**-0.59**
Grande Ronde Lower Main.	Insufficient Data					1000							
Joseph Creek	2325	2.62	0.14	1.81	2.76	1000	569	1908	**D**	2.33	2218	0.93	**-0.65**
Wallowa River	n/a	2.39	0.25	1.81	2.76	1000							
Imnaha River	n/a	3.02	0.15	1.81	2.76	1000							
Clearwater Populations (4)	Insufficient Data												
CW North Fork (blocked)	Fully Extirpated												
Salmon R. Populations (12)	Insufficient Data												
Wild Horse / Powder River	Insufficient Data												
Generic "B" run steelhead	272	1.01	0.22	1.94	3.14	1000	473		**B**	0.27	440	1.13	**0.12**
Generic "A" run steelhead	456	2.06	0.25	1.86	2.90	1000	419		**C**	0.46	154	1.99	**-0.03**

B.

Steelhead Populations	Population Statistics										5% Gap					
	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Min. Prod. @ Threshold	Min. Prod. @ Current Abund.	Abundance Check	Prod. Gap	Capacity Adjusted Productivity Gap	Observed 5% Gap
Wenatchee (hatch=1)	900	0.30	0.39	1.81	2.76	1500	4204	1081	**A**	0.60	1.30		0.00	3.33		**3.33**
Wenatchee (hatch=0.3)	900	0.65	0.39	1.81	2.76	1500	4204	1816	**A**	0.60	1.30		0.00	1.00		**1.00**
Methow (hatch=1)	309	0.19	0.63	2.02	3.36	1500	1300	278	**A**	0.21	1.30		0.00	5.84		**5.84**
Entiat (hatch=1)	94	0.26	0.35	1.80	2.72	500	229	77	**A**	0.19	1.64		0.00	5.31		**5.31**
Okanogan (hatch=1)	114	0.16	0.42	1.86	2.90	1000	406	89	**A**	0.11	1.39		0.00	7.69		**7.69**
Deschutes (westside)	470	1.47	0.14	1.81	2.76	1000	457	571	**C**	0.47	1.4		1.10	0.00		**0.75**
Deschutes (eastside)	1579	1.51	0.31	2.02	3.36	1000	1139	1649	**D**	1.58	1.4	1.30	1.16	0.00		**-0.14**
Klickitat River						1500					1.3					
Fifteenmile Creek	593	2.03	0.22	1.86	2.90	1000	323	624	**C**	0.59	1.4		1.90	0.00		**0.60**
Rock Creek	Insufficient Data					500					1.64					
White Salmon	Functionally Extirpated					1000					1.4					
Upper Yakima River	92	1.09	0.12	1.89	3.00	2250			**C**							
Naches River	462	2.00	0.16	1.89	3.00	1500	515	746	**C**	0.31	1.3		2.08	0.00		**1.01**
Toppenish River	148	2.20	0.20	1.89	3.00	500	223	319	**C**	0.30	1.64		1.68	0.00		**0.57**
Satus Creek	568	2.12	0.14	1.86	2.90	1000	324	627	**C**	0.57	1.4		2.03	0.00		**0.59**
John Day Lower Mainstem	1800	2.59	0.18	1.80	2.72	2250	825	1969	**C**	0.80	1.25		3.14	0.00		**0.14**
John Day North Fork	1740	2.41	0.22	1.81	2.76	1500	700	1713	**D**	1.16	1.3	1.28	2.71	0.00		**-0.47**
John Day Upper Mainstem	524	2.14	0.33	1.89	3.00	1000	528	827	**C**	0.52	1.4		2.06	0.00		**0.21**
John Day Middle Fork	756	1.93	0.18	1.81	2.76	1000	461	823	**C**	0.76	1.4		1.76	0.00		**0.21**
John Day South Fork	259	1.95	0.25	1.81	2.76	500	254	378	**C**	0.52	1.64		1.38	0.00		**0.32**
Umatilla River	1472	1.50	0.15	1.81	2.76	1500	846	1370	**C**	0.98	1.3		1.31	0.00		**0.09**
Walla Walla Mainstem	1003	1.41	0.61	2.92	6.96	1000	533	878	**D**	1.00	1.4	1.39	1.01	0.00		**-0.01**
Touchet River	Insufficient Data					1000					1.4					
Willow Creek	Functionally Extirpated					1000										
Tucannon River	Insufficient Data															
Asotin River	Insufficient Data															
Grande Ronde Upper Main.	1832	2.29	0.18	1.83	2.82	1500	791	1822	**D**	1.22	1.13	1.11	3.05	0.00		**-0.52**
Grande Ronde Lower Main.	Insufficient Data					1000										
Joseph Creek	2325	2.62	0.14	1.81	2.76	1000	569	1908	**D**	2.33	1.2	1.08	3.37	0.00		**-0.59**
Wallowa River	n/a	2.39	0.25	1.81	2.76	1000										
Imnaha River	n/a	3.02	0.15	1.81	2.76	1000										
Clearwater Populations (4)	Insufficient Data															
CW North Fork (blocked)	Fully Extirpated															
Salmon R. Populations (12)	Insufficient Data															
Wild Horse / Powder River	Insufficient Data															
Generic "B" run steelhead	272	1.01	0.22	1.94	3.14	1000	473	375	**B**	0.27	1.2		0.68	0.19	0.65	**0.65**
Generic "A" run steelhead	456	2.06	0.25	1.86	2.90	1000	419	660	**C**	0.46	1.2		2.43	0.00		**0.52**

C.	Population Statistics										1% Gap					
Steelhead Populations	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Min. Prod. @ Threshold	Min. Prod. @ Current Abund.	Abundance Check	Prod. Gap	Capacity Adjusted Productivity Gap	Observed 1% Gap
Wenatchee (hatch=1)	900	0.30	0.39	1.81	2.76	1500	4204	1081	**A**	0.60	1.54		0.00	4.13		**4.13**
Wenatchee (hatch=0.3)	900	0.65	0.39	1.81	2.76	1500	4205	1816	**A**	0.60	2.54		0.00	2.91		**2.91**
Methow (hatch=1)	309	0.19	0.63	2.02	3.36	1500	1300	278	**A**	0.21	1.54		0.00	7.11		**7.11**
Entiat (hatch=1)	94	0.26	0.35	1.80	2.72	500	229	77	**A**	0.19	2.20		0.00	7.46		**7.46**
Okanogan (hatch=1)	114	0.16	0.42	1.86	2.90	1000	406	89	**A**	0.11	1.67		0.00	9.44		**9.44**
Deschutes (westside)	470	1.47	0.14	1.81	2.76	1000	457	571	**C**	0.47	1.7		0.73	0.16		**0.75**
Deschutes (eastside)	1579	1.51	0.31	2.02	3.36	1000	1139	1649	**D**	1.58	1.7	1.54	0.78	0.13		**0.02**
Klickitat River						1500					1.56					
Fifteenmile Creek	593	2.03	0.22	1.86	2.90	1000	323	624	**C**	0.59	1.7		1.39	0.00		**0.60**
Rock Creek	Insufficient Data					500					2.2					
White Salmon	Functionally Extirpated					1000					1.7					
Upper Yakima River	92	1.09	0.12	1.89	3.00	2250					1.45					
Naches River	462	2.00	0.16	1.89	3.00	1500	515	746	**C**	0.31	1.56		1.56	0.00		**1.01**
Toppenish River	148	2.20	0.20	1.89	3.00	500	223	319	**C**	0.30	2.2		1.00	0.00		**0.57**
Satus Creek	568	2.12	0.14	1.86	2.90	1000	324	627	**C**	0.57	1.7		1.49	0.00		**0.59**
John Day Lower Mainstem	1800	2.59	0.18	1.80	2.72	2250	825	1969	**C**	0.80	1.45		2.57	0.00		**0.14**
John Day North Fork	1740	2.41	0.22	1.81	2.76	1500	700	1713	**D**	1.16	1.56	1.52	2.09	0.00		**-0.37**
John Day Upper Mainstem	524	2.14	0.33	1.89	3.00	1000	528	827	**C**	0.52	1.7		1.52	0.00		**0.21**
John Day Middle Fork	756	1.93	0.18	1.81	2.76	1000	461	823	**C**	0.76	1.7		1.27	0.00		**0.21**
John Day South Fork	259	1.95	0.25	1.81	2.76	500	254	378	**C**	0.52	2.2		0.77	0.13		**0.32**
Umatilla River	1472	1.50	0.15	1.81	2.76	1500	846	1370	**C**	0.98	1.56		0.92	0.04		**0.09**
Walla Walla Mainstem	1003	1.41	0.61	2.92	6.96	1000	533	878	**D**	1.00	1.7	1.69	0.66	0.21		**0.20**
Touchet River	Insufficient Data					1000					1.7					
Willow Creek	Functionally Extirpated					1000										
Tucannon River	Insufficient Data															
Asotin River	Insufficient Data															
Grande Ronde Upper Main.	1832	2.29	0.18	1.83	2.82	1500	791	1822	**D**	1.22	1.13	1.25	3.05	0.00		**-0.45**
Grande Ronde Lower Main.	Insufficient Data					1000										
Joseph Creek	2325	2.62	0.14	1.81	2.76	1000	569	1908	**D**	2.33	1.2	1.21	3.37	0.00		**-0.54**
Wallowa River	n/a	2.39	0.25	1.81	2.76	1000										
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Bibliography

ICTRT, 2005a . Viability criteria for application to Interior Columbia basin salmonid ESUs. Draft Report to NOAA-Fisheries. 50 p + attachments. July 2005.

ICTRT, 2005b. Updates to ESU/population viability criteria for the Interior Columbia basin. ICTRT memorandum. 30 pages. December 23, 2005.

ICTRT & R. Zabel 2006. Assessing the impact of anticipated hydropower changes and a range of ocean conditions on the magnitude of survival improvements needed to meet TRT viability goals. Draft Report. May ??, 2006.

ICTRT, 2006b. Required survival rate changes to meet Technical Recovery Team abundance and productivity criteria: Interior Columbia Populations. May 2006. 29 p.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-42, 156 p.

McElhany, P., T. Backman, C. Busack, S. Heppell, S. Kolmes, A. Maule, J. Myers, D. Rawding, D. Shively, A. Steel, C. Steward & T. Whitesel. 2003. Draft Willamette/Lower Columbia Pacific Salmonid Viability Criteria. March, 2003.